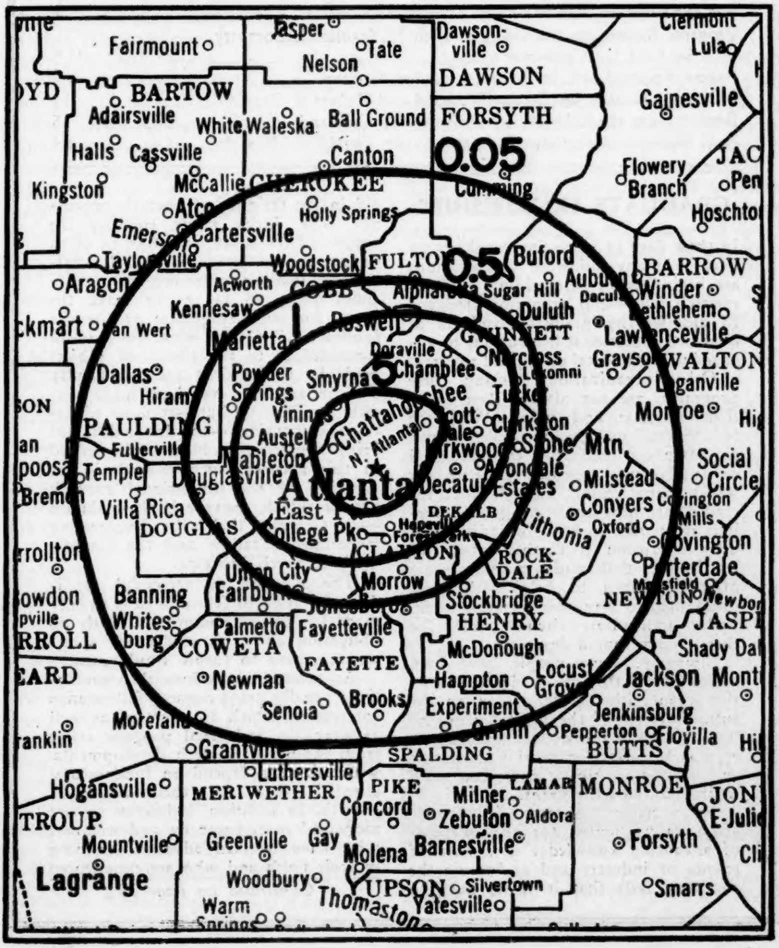
STATE ENGINEERING EXPERIMENT STATION

The Research Engineer

GEORGIA SCHOOL OF TECHNOLOGY

NOVEMBER ATLANTA, GEORGIA 1947



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Published bi-monthly, except in July, by the State Engineering Experiment Station of the Georgia School of Technology, Atlanta, Georgia. Issued as Circular 17 in the Station's publication series. Vol. IX, No. 12.

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GRADUATE FELLOWSHIPS

In these days of increasing emphasis on research, many industrial organizations are beginning or intensifying graduate research fellowship programs, designed to aid worthy graduate students at qualified educational institutions to engage in fundamental or applied research.

Other organizations, noting these programs, are not always clear as to their purpose and value. "Research fellowships" or "graduate fellowships" are often confused with the industrial or fundamental research projects for which many schools, Georgia Tech included, are now contracting with various industries, groups, or individuals. This confusion is further intensified by the fact that graduate students are often employed to help with these programs and may even use such work, under appropriate circumstances, for theses for advanced degrees.

Similarly, some people have been led to believe that the graduate fellowship grant either places a lien on the future services of the student receiving it or obligates the donor company to employ him after graduation, although such clauses are almost never contained in the terms of the grant.

In actuality, research fellowships are usually granted for the purposes of advancing knowledge in a field of science or industry and/or because the company feels that it is its duty to aid in the training of research personnel. The donor rarely specifies the subject of the study, although he often designates the field—chemical engineering, textile engineering, etc., sometimes going so far as to make the grant for such subphases as "textile lubrication." On occasion, he may be consulted as to the choice of subject made by the student and his faculty advisor, and may even have made concrete suggestions, but—at most educational institutions—the donor does not bring a specific problem to be solved in this manner; such research is the function of the professional research groups which many schools maintain —at Georgia Tech, the Engineering Experiment Station and the Georgia Tech Research Institute.

The selection of successful candidates for research fellowships is usually made by faculty committees, with no obligation either to student or sponsor in regard to future employment.

As mentioned, industrial organizations usually grant research fellowships for reasons which are practical as well as altruistic. Industrial progress stems from industrial research developments, which in turn depend on fundamental scientific data for their continued growth. In addition, industries require more and more engineers and scientists who have received advanced training in their fields and who are experienced

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FM PROPAGATION SURVEY OF THE ATLANTA AREA

By M. A. HONNELL*

Georgia Tech has been associated with electronic research in the field of radio broadcasting since the early 1920's. This article describes a study of FM propagation in the Atlanta area, made in order to determine the potentialities of FM broadcasting in this region. Much of the equipment required and the methods of data analysis had to be developed during the course of the survey, which is also of interest as an excellent example of studies needed to insure adequate FM reception.

As recently as the summer of 1944, no FM stations were in operation in Georgia. Therefore, in order to stimulate interest in this modern system of broadcasting and to determine its potentialities, Georgia Tech in June, 1944, initiated a program of research in FM propagation, conducted through the Engineering Experiment Station.

This article does not attempt to present more than a condensed summary of the results of this project, but the information contained is of immediate importance to radio broadcasters, in addition to taxi companies, public utilities, and railroads, many of whom are now installing FM communication systems for dispatching purposes.

EQUIPMENT

In order to carry out this program, an application was filed with the Federal Communications Commission for a developmental FM broadcast station, and a construction permit was granted in January, 1945, with call letters W4XAG. A Western Electric type 503 A-1 FM transmitter was received and installed in June, 1945.

The Western Electric transmitter was employed for the 49.5-megacycle survey. Assuming a 60 per cent plate efficiency and taking into consideration the losses in the transmission line, the effective power radiated by the vertical half-wave coaxial antenna was computed to be 1000 watts. The antenna was mounted on a small tower on top of the Electrical Engineering Building, as shown in Figure 1. The midpoint of the antenna was exactly 100 feet above ground.

For the 99-megacycle surveys, the transmitter was converted to Western Electric type 503 B-1. Assuming a plate efficiency of 50 per cent and making due allowance for the increased transmission line losses, the effective power radiated by the vertical coaxial antenna during the 99-megacycle (vertical polarization) survey was calculated to be 750 watts.

A horizontal square loop antenna was constructed for the horizontally-polarized transmissions. The measured power gain of this antenna was approximately 0.8 as compared to a horizontal dipole. Although the polar pattern of this antenna showed a slightly greater gain off the diagonals, the pattern was quite symmetrical. The effective radiated power for the horizontally-polarized transmission was computetd to be 600 watts using the antenna power gain value of 0.8.

The three field-strength surveys were made with the transmitting antennas mounted in identical positions on the tower in order to reduce to a minimum any er-

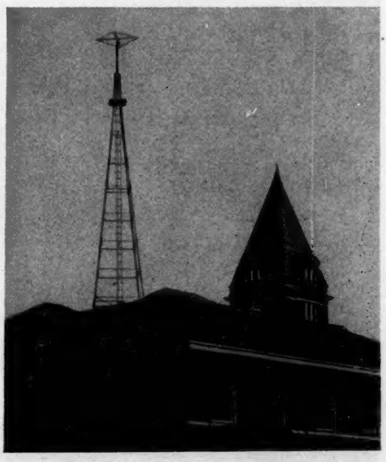

Figure 1. The square loop transmitting antenna on top of the Georgia Tech Electrical Engineering Building.

**Professor of Electrical Engineering and Research Associate, State Engineering Experiment Station.*

rors which might arise in making comparisons of the resultant measurements. The fact that each antenna employed consisted of a single bay provided an excellent basis for comparison work.

THE FIELD CAR INSTALLATION

Figure 2 shows the measuring equipment installed in the field car. The measuring equipment consisted of a Measurements Corporation Model 58 UHF Noise and Field Strength Meter, used in conjunction with an Esterline-Angus type AW five-milliampere recording meter. The recording meter was provided with an external drive shaft and an over-running clutch, and was connected to the speedometer cable through a 400:1 Boston reduction gear. With this arrangement, the chart paper was advanced 7.5 inches per mile. Each 0.75 inch division on the chart conveniently represented 0.1 mile. The recording meter was also equipped with a chronograph pen actuated by means of a six-volt battery and push-button in order that significant points on the chart might be accurately marked for subsequent identification.

Figure 3. The 99-megacycle horizontally-polarized loop antenna.

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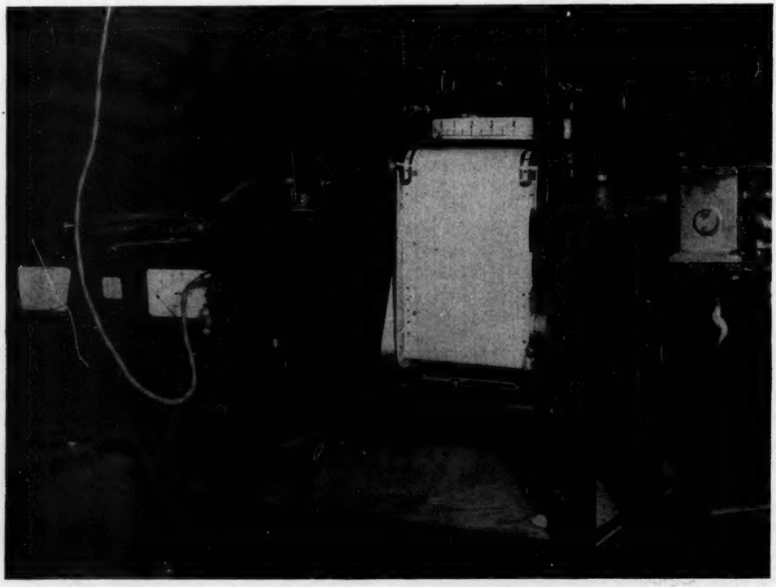

Figure 2. The field-strength measuring equipment mounted in the field car.

PROGRESS REPORT ON THE GEORGIA TECH HYDRAULICS LABORATORY

By CARL E. KINDSVATER*

Hydraulics, by definition, is that branch of engineering that deals with the behavior of fluids at rest or in motion. Traditionally, it is the practical science which embraces the elements of fluid mechanics, fluid measurements, and hydraulic machinery. The following article describes in detail the new Georgia Tech hydraulics laboratory and its potentialities for engineering education and research. Two anonymous sponsors have recently contributed $35,000 toward the equipping of this laboratory, depositing these funds with the Georgia Tech Alumni Foundation.

When Georgia Tech's new Civil Engineering building was constructed in 1938, space was provided and certain minimum facilities were incorporated in one wing of the building for the future development of a hydraulics laboratory. At the time, it was anticipated that this laboratory would be primarily an instructional facility, and certain elements of the floor layout were planned in a manner similar to the undergraduate hydraulics laboratory at Tulane University. Several pumps were purchased, but no other equipment was then secured, and limited hydraulics laboratory instruction continued to be offered by the Mechanical Engineering Department.

When plans for the construction of the hydraulics laboratory were revived in 1945, the author was added to the Civil Engineering staff and was given a free hand in developing a plan for a laboratory which would be suitable for research in hydraulics

*Associate Professor of Civil Engineering.

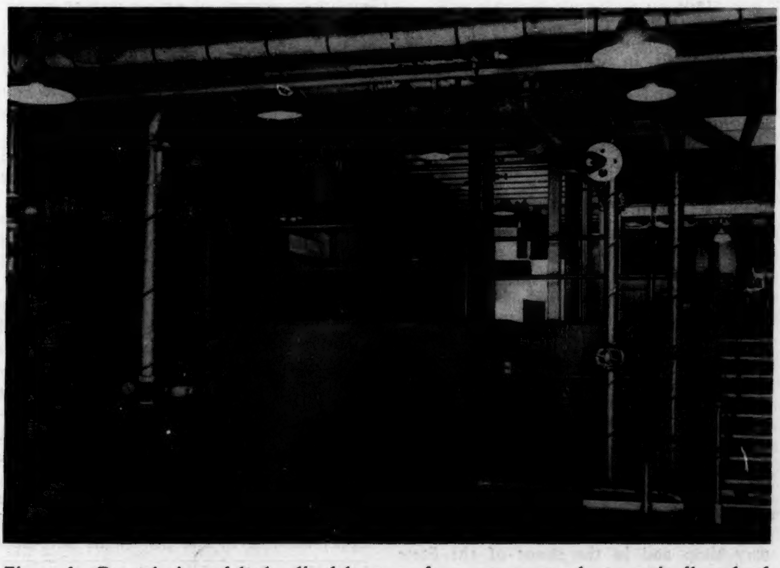

Figure 1. General view of hydraulics laboratory from entrance on lower main floor level.

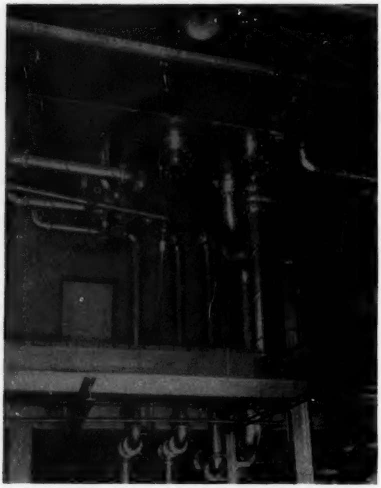

Figure 2. A constant head is maintained on all water-supply piping by means of this tank, which contains 364 linear feet of skimming weirs.

and fluid mechanics, as well as for instruction at both the undergraduate and graduate levels. In addition, the Civil Engineering Department's curriculum was revised to include more work in hydraulics and fluid mechanics, and courses were added to enable graduates in civil engineering to obtain a Master's degree with a major in hydraulics.

Funds having been made available through the Alumni Foundation, plans were completed and a contract for the construction of a basic water-circulation system was let in May, 1946. Hindered by delays in the procurement of materials, the contractor was unable to meet the original estimate of the completion date, and final operations on the initial contract were not finished until March, 1947. During this construction period, designs were completed and construction was commenced on a number of auxiliary laboratory facilities. This work continues, and important pieces of primary equipment are still being designed and fabricated, both in the laboratory shop and in the shops of the State Engineering Experiment Station.

THE PRESENT LABORATORY

Figure 1 shows the laboratory as it stands today. The building space is divided, as shown in the illustrations, into two main floor levels and a balcony. The main floor levels are six feet apart in elevation, an unfortunate circumstance which complicated the design and greatly increased the cost of the basic water-supply system. The lower main floor is a space approximately 24x36 feet, and the upper main floor is about 34 x 42 feet. The balcony has a useful floor space slightly more than half as large as that of the upper main floor. Each of the two main floor levels had originally been provided with closed loops of covered concrete channels. These channels in the new plan will serve only as water storage basins or sumps. The main water-circulation system, the construction of which constituted by far the most expensive item in the recently completed contract, consists principally of two separate pumping circuits. Thus, each of the main floor levels (and the balcony, as an adjunct to the upper floor level) is provided with an independent source of water. An important element of each pumping circuit is an elevated skimming weir type of "constant-head" tank (Figure 2), located in the rafters above the balcony level. In the recirculation process, water taken from city water mains and stored in the sumps is pumped first to the constant-head tanks. From these tanks it flows by gravity to all parts of the laboratory and back to the storage sumps.

The water distribution system consists mainly of six-inch, spiral-welded, flanged pipe. The entire piping system is designed for maximum flexibility of use. The pumps, tanks, and pipe lines are so located as to use a minimum of valuable floor and wall space. At the present time, only two pumps are connected to the water-circulation system. One, with a capacity of about two cubic feet per second, will serve equipment located on the lower main floor. A larger pump, with a capacity of five cubic feet per second, serves the upper floor. Cross-connections are provided to secure a combination of the two capacities on the upper floor level, and provisions have been

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PATENT APPLICATIONS

By EDWARD TAYLOR NEWTON*

Patent fallacies and requirements, invention records, and patent searching have so far been discussed in three articles of a series designed to inform the engineer and industrialist on phases of a subject of growing importance to their industrial operations. The current article is concerned with the preparation of a patent application, the final step required of an inventor who would seek patent protection. Patent drafting is a complex art, and many of its phases are considered in this article. Other installments will deal with patent prosecution, patent usage, and patent trends.

The rules of practice[1] relating to the grant of Letters Patents of the United States are promulgated by the Commissioner of Patents, approved by the Secretary of Commerce, and are designed to be in strict accordance with the Revised Statutes of the United States to which they relate.

These statutes[2] provide that patent may be obtained by any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvement thereof, or who has invented or discovered and asexually reproduced any distinct and new variety of plant, other than a tuber-propagated plant, not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof, or more than one year prior to his application, and not patented in a country foreign to the United States on an application filed by him or his legal representative or assigns more than twelve months before his application, and not in public use or on sale in the United States for more than one year prior to his application, unless the same is proved to have been abandoned, upon payment of the fees required by law and other due proceedings had. These "other due proceedings" refer to the formal application.

A complete application contains the following parts: a petition, an oath, a drawing when the nature of the invention requires it, a specification with one or more claims, and a first (filing) fee of $30.00, plus $1.00 for each claim in excess of twenty.

An application for a patent will not be considered for examination until all of its parts have been received in the Patent Office. It is desirable, therefore, that all parts of the complete application be deposited in the Patent Office at the same time and that all the papers embraced in the application be attached together.

The personal attendance of applicants at the Patent Office is unnecessary, and all business with the office should be transacted in writing. Legal size paper, 8½x13 inches, is deemed preferable, and the subject matter must be plainly written or printed (preferably typewritten) on one side of the paper only with a wide margin reserved on the left-hand side of the page.

THE PETITION

The petition must be addressed to the Commissioner of Patents and must state the name, residence, and post office address of the petitioner requesting the grant of a patent. It must designate by title the invention sought to be patented and contain a reference to the specification for a full disclosure of such invention.

The petition must be signed by the inventor; in case of his death, by his executor or administrator; or, in case he becomes insane, by his legally appointed guardian, conservator, or representative.

When more than one person has contributed to the inventive process, the petition must be signed by all of the inventors. In such case, they are joint in-

Registered Patent Attorney, Atlanta, Georgia; B. S. in E. E., Georgia School of Technology, 1926; LL.B., George Washington University, 1934; M.P.L. and S.J.D., National University, 1935.

[1] *Rules of Practice in the United States Patent Office.*

[2] *Revised Statutes,* Sections 4886, 4887.

ventors and may be entitled to a joint patent, but no one of them can legally obtain a patent for an invention jointly invented by them. The fact that one person furnishes the capital and another makes the invention, however, does not entitle them to make an application as joint inventors.

A power of attorney is usually made a part of the petition. An inventor may prepare and file his own application, but he is advised[8], unless familiar with such matters, to employ a competent registered attorney, as the value of patents depends largely upon the skillful preparation of their specification and claims.

The usual form of the petition is as follows:

TO THE COMMISSIONER OF PATENTS:

Your petitioner, ______________, a citizen of the United States and a resident of ________, in the County of ________ and State of ________, whose post office address is ________, prays that letters patent may be granted to him for the improvement in ________, set forth in the annexed specification; and he hereby appoints ________, of ________, State of ________, his attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith.

THE OATH

The applicant, if the inventor, must make oath or affirmation that he believes himself to be the original and first inventor or discoverer of the art, machine, manufacture, or composition; or an improvement thereon; or the variety of plant for which he solicits a patent; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, and must state the country of which he is a citizen and where he resides, also whether he is a sole or joint inventor of the invention claimed in his application.

[8]Rule 17, *Rules of Practice in the United States Patent Office*, and *Inventors' Guide*, U. S. Department of Commerce.

In addition, the applicant must distinctly state under oath that to the best of his knowledge and belief the invention has not been in public use or on sale in the United States for more than one year prior to his application, or patented or described in any printed publication in any country before his invention or more than one year prior to his application, or patented in any foreign country on an application filed by himself or his legal representative or assigns more than twelve months prior to his application in this country.

If any application for a patent has been filed in any foreign country by the applicant, or by his legal representative or assigns, prior to his application in this country, he must state the countries in which such application has been filed, giving the date of such application, and must also state that no application has been filed in any other country or countries than those mentioned; if no application for a patent has been filed in any foreign country, he must state this.

If the application is made by an executor or administrator of a deceased person or the guardian, conservator, or representative of an insane person, the oath must allege the relationship of the affiant to the inventor and, upon information and belief, the facts to which the inventor is required to make oath.

The oath must be subscribed to by the affiant, and it may be made before any person within the United States who is authorized by law to administer oaths, such as a notary public, judge, or magistrate having an official seal. The oath must be attested in all cases by affixing the proper official seal of the officer before whom the oath is made.

The following is a customary form of oath:

______________ }
______________ } *S. S.*

______________, the above named petitioner, being sworn, deposes and says that he is a citizen of the United States and resident of ________, State of ________, that he verily believes himself to be the original, first, and sole inventor of the improvement in ________ described and claimed in the

annexed specification; and that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, or patented or described in any printed publication in any country before his invention or discovery thereof, or more than one year prior to this application, or in public use or on sale in the United States for more than one year prior to this application; that said invention has not been patented in any country foreign to the United States on an application filed by him or his legal representative or assigns more than 12 months prior to this application; and that no application for patent or said improvement has been filed by him or his representatives or assigns in any country foreign to the United States.

Inventor's full signature

Sworn to and subscribed before me this ________ day of ________, 194___.

Signature of Notary

(SEAL)

THE DRAWING

The applicant for a patent is required by law[4] to furnish a drawing for his invention whenever the nature of the case admits it; but a model will not be admitted as a part of the application except when, on examination of the case in its regular order, the Primary Examiner finds it to be necessary or useful and then requires it.

The drawings must show every feature of the invention covered by the claims. When the invention consists of an improvement of an old machine, the drawing must exhibit, in one or more views, the invention itself, disconnected from the old structure, and also in another view, so much only of the old structure as will suffice to show the connection of the invention therewith.

The drawing may be signed by the inventor; or, as is customary, the name of the applicant may be signed on the drawings by his attorney.

[4] *Revised Statutes*, Section 4889.

Applicants are advised[5] to employ competent draftsmen to make their drawings, but the Patent Office will furnish the drawings at cost, as promptly as its draftsmen can make them, for applicants who cannot otherwise conveniently procure them.

In order to obtain a uniform standard of excellence, the Patent Office rules regarding the drawings are rigidly enforced, and any departure from them will be certain to cause delay in the examination of an application. The following excerpts show the detailed exactness of the rules:

1. Drawings must be made upon pure white paper of a thickness corresponding to two-sheet or three-sheet Bristol board. The surface of the paper must be calendered smooth. India ink alone must be used for pen drawings, to secure perfectly black solid lines.

2. The size of a sheet on which a drawing is made must be exactly 10 x 15 inches. One inch from its edges a single marginal line is to be drawn, leaving the "sight" precisely 8 x 13 inches. Within this margin all work and signatures must be included. One of the shorter sides of the sheet is regarded as the top, and, measuring downwardly from the marginal line, a space of 1¼ inches is to be left blank for the heading of title, name, number, and date.

3. All drawings must be made with the pen or by a photolithographic process which will give them satisfactory reproduction characteristics. Every line and letter (signatures included) must be absolutely black. This direction applies to all lines, however fine, to shading, and to lines representing cut surfaces in sectional views. All lines must be clean, sharp, and solid, and they must not be too fine or crowded. Surface shading, when used, should be open. Sectional shading should be made by oblique parallel lines, which may be about one-twentieth of an inch apart. Solid black should not be used for sectional or surface shading. Free hand work should be avoided whenever it is possible to do so.

The foregoing excerpts by no means

[5] Rule 55, *Rules of Practice in the United States Patent Office.*

constitute all of the rules relating to the drawing, but will suffice to indicate some of the many requirements which must be met.

THE SPECIFICATION

The specification is a written description of the invention and of the manner and process of making, constructing, compounding, and using the same, and it is required[6] to be in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which the invention or discovery appertains, or with which it is most nearly connected, to make, construct, and use the same.

The specification must set forth the precise invention for which a patent is solicited and must explain the principle thereof and the best mode in which the applicant has contemplated applying that principle, in such manner as to distinguish it from other inventions. The description should refer to the figures of the drawing by number and to the different parts by numerals. The specification must conclude with one or more claims to point out and distinctly claim the part, improvement, or combination which the applicant regards as his invention.

The following order of arrangement should be observed in writing the specification:

1. Preamble stating the name, citizenship, and residence of the applicant, and the title of the invention.
2. General statement of the object and nature of the invention.
3. Brief description of the several views of the drawing.
4. Detailed description.
5. Claim or claims.
6. Signature of the applicant.

Before attempting to write the specification, it is absolutely essential that the writer have a complete mental picture of the invention in all of its various ramifications, a full understanding of the function and operation of each of the various parts, knowledge of the features wherein the invention differs from the prior developments, and appreciation of the inherent advantages.

A careful study of the invention is necessary to determine all of the salient features and the distinctions between the invention and the prior developments in the art as disclosed by a preliminary search, whose preparation has been discussed in a previous article[7] in this series.

As the study progresses, it may be found helpful to make notes of the function and operation of the various parts, of the features wherein the invention differs from the prior art, of the advantages present, and of terminology employed in related matters.

If the invention is a new machine, the study will necessitate a determination of the reasons why the new machine is actually an improvement and must take into consideration such factors as, for example, faster operation, economy of operation, improved product, fewer imperfect articles produced, etc. Having determined these factors, it is then necessary to analyze the operation of the machine and determine how and why these advantages are obtained, and to what extent they are attributable to the parts of the machine which differ structurally from the prior constructions.

Similarly, if the invention is an improved product, the study should include a comparison of the new product with earlier known products as to materials, physical characteristics, and general form and arrangement in order to determine the differences and their relation, if any, to the advantages of the new product.

Similar studies of inventions relating to other subject matters will readily suggest themselves; upon completion of the suggested study in each case, material will have been accumulated which will be invaluable in the preparation of the written description and in drafting claims.

With sufficient information at hand, the claims may be drawn either before or after writing the description in the specification; but there is reason to prefer the drafting of at least a few claims first, with the thought that the description can then be

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[6] *Revised Statutes*, Section 4888.

[7] Lane, J. C., *THIS JOURNAL*, 9, No. 11, 7 (1947).

INDUSTRIAL WASTES

By GEORGE W. REID* *and* ROBERT S. INGOLS**

Almost all manufacturing industries, especially those which use large quantities of water in their processes, find it necessary to dispose of waste by-products—materials of little value or present in solution in such minute quantities that their recovery is uneconomic or almost impossible. This article presents a review of the present situation and a discussion of what is being done to solve the problems involved.

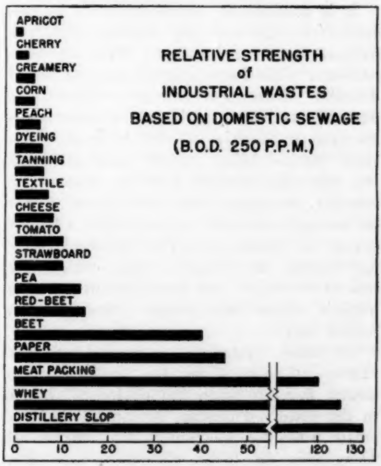
Industry, today, is faced with many problems concerned with the disposal of industrial wastes. Waste treatments cost money, often enough to make manufacturing operations uneconomic should their application be made mandatory. On the other hand, no one company can deny that other users of a stream have an equal right to receive water sufficiently pure for their purposes —be it for drinking, chemical processing, boiler use, or the like, and there is no cause for wonder that controlling agencies of waters receiving industrial wastes are exercising increasing pressure on industry to take care of these troublesome materials.

EFFECTS OF WASTES

When an industrialist is told that the wastes from his plant cannot be discharged directly into a stream, he is often prone to feel that this dictum is mere officiousness and to argue that the effluent "is merely a dilute solution," that "it contains good food," or that "it is only clear water." Unfortunately, however, any discharge other than pure water of proper temperature has a deleterious effect on the condition of the stream, in which there exists a delicate balance between millions of complex microorganisms and many varieties of fish.

Even the discharge of wastes in amounts so small as to render them undetectable chemically may alter this biological balance of the microorganisms to the point where certain groups may be entirely eradicated. When this happens, those groups of fish which might themselves readily live in a stream containing this waste, yet which depend on these microorganisms for food, must either migrate or die. Other effluents, of course, produce far more drastic results.

Stream contaminants may be readily classified into several groups. Some interfere mechanically with the respiratory or metabolic functions of the organisms. A slimy material such as pumpkin waste may clog the gills of fish and suffocate them. Limestone slurry from an acetylene or water softening plant may blanket the bottom of a stream and kill the benthonic fauna. High velocity streams carrying heavy loads of sand or grit may erode the floor benthos. Sometimes a small amount of coloring matter, such as is found in cotton dye wastes, will filter out the sunlight needed for the survival of the green algae which serve as the principal source of food for many groups of aquatic life. These types of mechanical-action contaminants generally do not kill all the life in a stream, but they are more or less specific in their action on certain microorganisms and must



*Associate Professor of Civil Engineering.
**Research Associate Professor of Chemistry.

often be eliminated before serious damage results.

ORGANIC WASTES

The discharge of any organic matter which may be used directly as food by any one group of organisms may cause many far-reaching changes in a stream. Bacterial growth is accelerated by the increased supply of food, resulting in a greater consumption of oxygen since bacteria oxidize the organic matter, thus creating a depression in the level of oxygen dissolved in the water. The extent of this oxygen loss depends primarily upon two factors: the oxygen utilization by bacteria as controlled by the amount of food added, and the relative rates of reaeration by plants, surface contacts, rapids, etc. Pollution quite often causes dissolved oxygen to disappear, whereupon the stream becomes septic, forming odoriferous gases.

When dissolved oxygen values approach zero parts per million (p.p.m.), all higher forms of life, including fish, are killed. Indeed, most species of fish migrate when this value approaches 3 p.p.m. The brook trout is one of a class of fish which will not tolerate any decrease in oxygen content below the saturation point. Since trout fishing is such a favorite of sportsmen, this in part explains the desire of many of their organizations to abolish all types of stream pollution.

It is particularly unfortunate for stream sanitation that, in any stream, dissolved oxygen levels vary inversely with the temperature, while bacteriological activity varies directly. Therefore, oxygen content is normally at its lowest in hot weather when the rate of bacterial activity is at its peak, these factors being further intensified by the fact that stream flow is smallest in summer. In some cities, this situation has led sewage treatment plants to give a higher degree of treatment to their domestic sewage during the summer than during the rest of the year, and industries discharging organic wastes into streams must perforce follow suit.

In many instances, as mentioned, the extent of damage to the ecology of a stream depends upon the degree of change in the dissolved oxygen content. Relatively small amounts of waste are capable of using this up at an untoward rate. For example, a stream having the capacity of one million gallons per day (or 1.5 cubic feet per second at 20° C.) contains 8.5 p.p.m. of oxygen at the saturation point, or approximately 70 pounds in the entire million gallons. To use this in one day's flow (without reaeration) would require about 400 pounds of food, an amount which could be supplied by 5,000 gallons of a 0.1% concentration of an organic waste or by approximately 20,000 gallons of sewage.

The canning, dairy, and meat packing industries account for a large portion of the oxygen-consuming wastes which enter the streams. Georgia, for example, has some 40-odd canneries, dispersed through 20 counties, where approximately 6,000 persons are engaged in packing peaches, fruit juices, pears, tomatoes, beans, pickles, potatoes, okra, pimentos, and turnips. The dairy and meat packing industries are not quite as extensive here as in some other states, although some 2,000 and 3,000 persons respectively, are employed by them.

Georgia has several large pulp and paper mills, whose organic wastes are particularly difficult to handle. The National Council for Stream Improvement, Inc., of which the Georgia kraft paper mills are members, has recently been concentrating research on methods of treating these types of wastes.

These and similar industries are vital to the agricultural and industrial growth of the state, and the oxygen loss occasioned by their plant effluents, the most frequent source of trouble in our streams, poses a challenge to research.

INORGANIC WASTES

Several forms of inorganic wastes cause a great amount of damage to stream life. For example, the higher forms of aquatic life are very sensitive to fluctuations in the acidity or alkalinity of the water (here expressed in terms of pH). Most fish can live in waters having a pH range of 6.5 to 8.5, but beyond this range the extent of damage to the fish will be determined by the degree of variation and its duration. Many inorganic and some organic wastes may contain acids or materials from which bacterial action will produce acidity.

When the polluting material causes both changes in pH and in oxygen depletion,

the effect is additive, and a very small change in either factor may cause the higher forms of life to die or migrate. However, polluted streams contain so many varieties of bacteria that at least some species survive even the worst pollution or are reinnoculated into the water from the soil without any apparent break in the life cycle.

Fish and even bacteria are sensitive to rapid changes in the salinity of the water—more technically speaking, to changes in the osmotic pressure caused by increased concentrations of dissolved materials; the salmon and eel are notable exceptions. Many nontoxic soluble materials may therefore cause much biological damage if their concentration becomes suddenly too high. An example of this phenomenon is the trouble sometimes occasioned by the discharge of the brine wastes from crude oil production.

On the other hand, there are many poisonous substances which can do great damage even in very low concentrations. For example, solutions of cyanides and such metals as copper, chromium, mercury, arsenic, and lead are very injurious or even lethal to all forms of life, including human. Many of these soluble inorganic substances are not removed by the usual water treatment devices and must therefore be kept out of potable water sources; similarly, their disposal in nonpotable waters must be handled carefully. In one instance the authors, following slugs of cyanide waste discharged by a steel plant, traced their course down a large river for some eighty miles, noting dead fish all the way.

TREATMENT

The best treatment for any industrial waste is dependent upon so many factors that recommendations must always be based on the particular circumstances. However, there are some generalities which may be of interest here. Where an industry is relatively small, joint treatment of its wastes in a city sewage treatment plant may have several points of advantage. The added capacity required for a joint plant is far less expensive to build and to operate than the establishment of separate plants.

However, the problem of working out an equitable agreement for cost distribution is often difficult. In small towns, the financial burden is often distributed on the basis of population equivalent strengths.

From a technical viewpoint, the use of a joint treatment plant is frequently successful because one waste may complement another. For example, the components of candy or sugar wastes are not enough to make them a complete food, while an excessive amount of their necessary complements (nitrogenous compounds and inorganic salts) are contained in ordinary sewage. No usual method of separate treatment would be sufficient to remove all of the sugar from such industrial wastes or all of the necessary complement from the sewage, so that a very rapid oxygen depletion would occur in a stream receiving these two wastes separately. If both are treated together in a properly designed biological treatment plant, the stream should be well protected from pollution. Similarly, intermittently produced acidic and alkaline wastes, if mixed before discharge, may be far less destructive to stream life.

One of the principal causes of industrial waste damage is the "flash" discharge into a stream of large amounts of a material at any one time. To prevent this, balancing tanks may be used to stabilize the rate of discharge, or lagoons large enough to store the waste for several days or even months may permit a uniform discharge rate for the waste, with much less damage to the stream or to treatment equipment.

It has often been noted that canning wastes present a difficult problem, inasmuch as the "pack" time seldom exceeds two months. This time is hardly sufficient to permit adequate biological treatment, and chemical treatment would be quite expensive as well as possibly ineffective. Therefore, these wastes are usually impounded, stabilized by lagooning, and then finally discharged bit by bit when water levels are high. Phenol, likewise, is very toxic in high concentrations, but can be easily rendered harmless through biological treatment if a low concentration is maintained steadily. A lagoon with sufficient capacity for two or three days' effluent will generally provide enough mixing to permit subsequent treatment. Similarly, a lagoon may serve to permit the interaction of acidic and alkaline wastes which are produced intermittently, and may also serve

as a settling tank for the removal of suspended material.

When biological treatment is necessary, two distinct types are available for use, one being suitable for use with dilute solutions and the other being superior for use with concentrated solutions. Since dilute wastes are usually voluminous, their treatment must be rapid if the necessary equipment is to be of reasonable size; concentrated wastes, however, can be handled more slowly and stored longer if the construction or operation costs are not too high. For the treatment of dilute wastes, rapid aerobic biological methods are most suitable. Anaerobic treatments are quite slow, but equipment for them is frequently cheaper to build and operate; in addition, they sometimes yield by-products of real value such as methane gas.

Of course, the best procedure to follow is to use no treatment at all if products which can be salvaged from the waste will reduce its pollutional nature. One outstanding example of the profitable utilization of wastes is the production of whey by the dairy industry. Certain cheese plants claim that they obtain more profit per pound of milk from dehydrated whey than from certain of their cheeses. This situation, unfortunately an exception, results from the demand for whey for use as a culture medium in the production of penicillin biotics. There are other outstanding examples of such waste utilizations, and many more will be added to the list as necessity forces industry and government to increase their research activities.

LEGAL ASPECTS

A land owner who has a river flowing through his property has a justifiable right to the reasonable use of its water. Similarly, a downstream owner is entitled to have this river enter his land undiminished in quantity and quality. The crux of the problem lies in the correct interpretation of the term "reasonable use." Most states have closed to use any streams whose contamination will endanger public health. Wherever there exists a real danger that bacteriological or chemical poisons may pollute the water supply, this view should be supported without question. However, several powerful groups of sportsmen have strongly urged that Federal measures be enacted to abolish all possible stream pollution, in order to preserve or permit the increase of fish life.

Wherever chemists and engineers have developed adequate and economic treatment processes, all parties have been satisfied; unfortunately, many of the methods of treatment developed so far are too expensive for industrial use. Courts, when lawsuits arise, will certainly continue to demand waste abatement when treatment processes are so developed as to be economically commensurate with the industry involved. State boards of health and the United States Public Health Service, realizing the technical difficulties and the cost involved in the treatment of liquid industrial wastes, have long been requesting increased appropriations from the Federal government and from private industry in order to permit intensified research on some of these problems, while asking at the same time that control of stream conditions be left in the hands of state authorities.

For the past ten years, sportsmen's groups and the various health authorities have sponsored legislation in Congress for stream improvement, but only in 1946 were these measures consolidated in a compromise bill which, however, was not enacted. Another such bill was proposed this year, but was not passed during the last session of Congress. This measure would have limited Federal control to interstate waters, and then only where the situation is very critical and where the states have failed to act themselves. It would also have provided funds for research.

Many states and groups of states have established stream pollution control boards vested with the power to demand abatement or to levy fines. Such boards will probably grade the large streams in order to provide for waste disposal in certain areas. Inasmuch as a mutually satisfactory solution to the problems of the two interested groups, industry and the controlling agencies, can be obtained more quickly through technological advances in waste treatment, money for research on methods of sewage disposal will in all probability be made increasingly available to such agen-

Continued on Page 23

REPORT FROM THE LIBRARY

By DOROTHY M. CROSLAND*

There are so many new developments and new discoveries in the fields of engineering and science that a book written in one of these fields is often out of date upon publication. However, there are many reference books that are fully as important as the current periodical literature. A chemical library would not be adequate without Beilstein's "Handbuch der Organischen Chemie" and Washburn's "International Critical Tables." Because periodical literature is so essential for research and graduate work and because Georgia Tech is building a strong graduate school and cooperating with many institutions and industrial companies in research, we have been busy either completing or acquiring complete files of journals, but books have not been neglected.

You have been told of our most outstanding acquisitions in periodicals. It is easy to write about them because it is often fascinating to search for and find a file of journals. It is most gratifying when you can produce for a research student such journals as the *Annales de Chimie et de Physique* for 1854 and see his face light up. You have scored a touchdown, and you feel that you have had a minor part in his research.

A college library must have other books in addition to its periodicals and reference volumes. Freshmen must have books for their English courses. Students of social science courses require many titles for their collateral readings. The Modern Language Department wants French, German, and Spanish titles. Principally, however, Georgia Tech acquires books on science and technology.

New books are intriguing items. One often makes mental notes of fascinating titles that will be read when there is time, but there are so many new books now published in all fields of knowledge that it is hard to select just a few. In this issue, however, I shall list some of the volumes that have been added to the Georgia Tech collection this summer. In the future I

shall, from time to time, give you short bibliographies, annotated titles, or occasional book reviews. If there is any particular information that you want from your library, by all means write to me or to the editor of THE RESEARCH ENGINEER. We want our library to be invaluable to you.

The following recent books may be found in the Georgia Tech Library:

Adams, H. S., *Milk and Food Sanitation Practice.* New York, Commonwealth Fund, 1947. $3.00. A practical text in the field of environmental sanitation designed to help public health engineers bridge the gap between theory and practice.

Anderson, Raymond W., *Romping Through Mathematics.* New York, Alfred A. Knopf, 1947. $2.50. A story of how, during four thousand years, the necessary mental tools for counting and measuring were collected and arranged.

Daunt, J. G., *Electrons in Action.* London, Books Limited, 1946. 6s net. The book gives an account, in simple language, of the fundamental action of electricity, upon which so many branches of science depend.

Dudley, John W., Jr., *Examination of Industrial Measurements.* New York, McGraw-Hill, 1946. $2.00. Acquaints engineers with simple and adaptable statistical techniques for the detection of variation in industrial products. Important types of data which reveal causes of variation are discussed, and effective methods for collecting,

**Librarian, Georgia School of Technology.*

analyzing, and presenting them are explained.

Engineering Production Annual. London, Paul Elek, 1944. 8.6s. This book gives a concise review of all important development work carried out during the past year or so, gleaned from hundreds of articles, bulletins, and lectures.

Fink, Donald G., *Radar Engineering.* New York, McGraw-Hill, 1947. $7.00. This volume is designed specifically to acquaint engineers and technical workers in radio and electronics with the new techniques and with special applications of old techniques used in radio detecting and ranging of objects.

Fox, M. R., *Vat Dyestuffs and Vat Dyeing.* Chapman and Hall, London, 1946. 24s net. The book should be valuable to all who are connected with the practical application of vat dyestuffs. It includes a brief description of their history and chemistry.

Frankel, P. H., *Essentials of Petroleum.* London, Chapman and Hall, 1946. 15s net. This volume is written by an oilman who sees the day-to-day developments of his business against the background of economic theory.

Jordanoff, Assen, *Dials and Flight.* New York, Harper, 1947. $5.00. A discussion of aviation instruments by a world famous authority. This book should appeal to all who are interested in flying, whether on a commercial or private basis.

Kirschenbauer, H. G., *Fats and Oils, an Outline of Their Chemistry and Technology.* New York, Reinhold, 1944. $2.75. This little volume presents a brief, simple survey of the origin, methods of extraction, chemistry, and processing of fats and oils. It answers dozens of questions.

Lowe-Brown, W. L., *An Introduction to Soil Mechanics.* 2nd ed. New York, Pitman, 1947. $1.00. This book discusses, from the point of view of civil and constructional engineers, architects, and builders, the characteristic properties of soils and their capacity for scientific measurement, with the nature of the various tests now employed in soil mechanics practice.

Massachusetts Institute of Technology, *Principles of Radar.* 2nd ed. New York, McGraw-Hill, 1946. $7.50. This volume should prove valuable not only to those interested in radar, but also to those concerned with ultra-high frequencies and microwaves, television, pulse-time communication systems, or pulse navigation systems.

Orchard, F. C., *Electricity in the Building Industry.* London, Chapman and Hall, 1946. 16s net. This volume offers guidance to the building industry, and it should do much to assist the builder in the solution of electrical problems.

Richter, Walter, *Fundamentals of Industrial Electronic Circuits.* New York, McGraw-Hill, 1947. $4.50. The purpose of this volume is to show the fundamental principles applying to circuits containing vacuum tubes, reducing such circuits to a combination of more familiar circuit elements so that the average electrical engineer and practical man can analyze the performance of the circuits.

Strong, Ralph K., *Chemistry for the Executive.* New York, Reinhold, 1946. $6.00. Book written with the idea of making chemistry clear to everyone, especially those in business and nonscientific professions.

In addition, the following classified lists of recent additions to our library may be of some interest to you:

AVIATION

Aircraft Yearbook. 1947.

Conway, H. M., *Principles of High Speed Flight.* 1947.

Smith, G. G., *Gas Turbines and Jet Propulsion for Aircraft.* 4th ed. 1946.

Titterton, G. F., *Aircraft Materials and Processes.* Rev. ed. 1941.

ARCHITECTURE

Brady, G. S., *Materials Handbook.* 1947.

Burris-Meyer, Elizabeth, *Contemporary Color Guide.* 1947.

Pevsner, Nikolaus, *An Outline of European Architecture.* 1945.

Raber, B. F., *Panel Heating and Cooling Analysis.* 1947.

CERAMICS

Bogue, R. H., *Chemistry of Portland Cement.* 1947.

Ceramic Industry, *Pottery Production Processes.* 1946.

Haggar, R. G., *Recent Ceramic Sculpture in Great Britain.* 1946.

Newark, N. J., Museum, *Pottery and Porcelain of New Jersey.* 1947.

ENGINEERING AND APPLIED SCIENCE

Bendz, W. I., *Electronics for Industry.* 1947.

Delmonte, John, *The Technology of Adhesives.* 1947.

Nault, Raymond, *The Chemistry and Technology of Plastics.* 1947.

Naves, Y. R., *Natural Perfume Materials.* 1947.

Pipes, L. A., *Applied Mathematics for Engineers*. 1946.

Tucker, J. I., *Contracts in Engineering*. 1947.

Watson, W. H., *Physical Principles of Wave Guide Transmission and Antenna Systems*. 1947.

SCIENCE

Bennett, Harry, *Concise Chemical and Technical Dictionary*. 1947.

Conant, James B., *On Understanding Science*. 1947.

Cork, J. M., *Radioactivity and Nuclear Physics*. 1947.

Pledge, H. T., *Science Since* 1500. 1939.

Welcher, F. J., *Organic Analytical Reagents*. v.1. 1947.

TEXTILES

Davison's Textile Bluebook. 1947.

Jackson, L. H., *Yarn and Cloth Calculations*. 1947.

Manual of Textile Industry of Canada. 1947.

Matthews, J. M., *The Textile Fibres*. 5th ed. 1939.

Society of Dyers and Colourists, *Symposium on the Chemistry and Properties of Cellulose*. 1939.

Teplitz, Irving, *Principles of Textile Converting*. 1947.

FM PROPAGATION SURVEY

Continued from Page 4

The mounting arrangement for the antenna on the field car is shown in Figure 3. The vertical oak mast is hinged at its midpoint in order that the antenna may be lowered to pass under low-hanging tree branches and other obstructions. A rubber bumper mounted below the antenna serves to protect the antenna when it rests on the top of the car. The antenna shown in Figure 3 is the horizontally-polarized loop antenna employed at 99 megacycles. Vertical half-wave dipoles mounted with their centers exactly 10 feet above ground were employed for the vertically-polarized surveys made on 49.5 and 99 megacycles.

CALIBRATION OF FIELD CAR ANTENNAS

Since a large conducting body such as a car distorts the directivity characteristics of a high-frequency antenna mounted in its immediate vicinity, it was necessary to obtain the polar field pattern of each car antenna employed by direct measurement. All antenna calibration work was carried on in the middle of a horse racing track at North Fulton Park, seven miles due north of the transmitter. This location was selected because it is the only level and open area found in the vicinity of Atlanta in which the standing waves are reasonably low and in which disturbances caused by passing cars are not too frequent.

The field car was initially driven about the open field until a region of maximum field strength was located which showed a gradual decrease of field strength as the car was moved away from this particular area. At this location, a wooden peg was driven in the ground at a point directly beneath the car antenna. Next, a transit was employed to lay out 12 points spaced 30° apart on a circle approximately 80 feet in diameter. Wooden pegs were driven in the ground at each of these points in order to identify them clearly.

The field-strength meter was placed on the ground near the center of the circle, and the standard field antenna was placed over the center peg in order to measure the field strength at that point. Care was exercised to reduce to a minimum errors caused by moving, reflecting objects.

The measuring equipment was replaced in the field car, and the car was carefully aligned in turn with each of the pegs on the periphery of the circle in such a manner that the car antenna was located precisely over the center peg. For each of these positions, a field-strength reading was recorded. The calibration of the field-strength meter was checked for every other reading taken.

A typical car antenna pattern for the antenna of Figure 3 is shown in Figure 4.

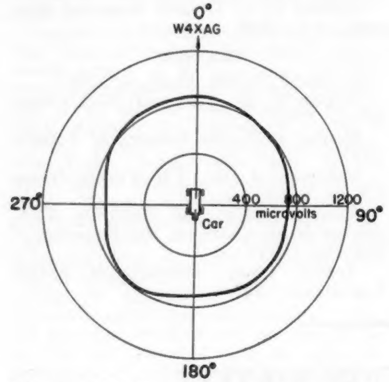


Figure 4. Relative car antenna pattern, horizontal circular antenna mounted on rear of car with center 10 feet above ground. Horizontal polarization. 99 mc. Field strength reading with standard antenna at 10 feet is 1500 microvolts. Antenna constant = 0.513.

It is interesting to note that the horizontal loop antenna has a polar pattern which is essentially circular. The field gain of 0.513 compared to a horizontal dipole is satisfactory, since the minimum signal which can be measured is determined by the ignition interference.

SURVEY OF ROUTES

One of the most important factors in a high-frequency field-strength survey is

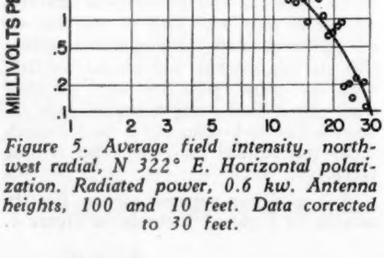


Figure 5. Average field intensity, northwest radial, N 322° E. Horizontal polarization. Radiated power, 0.6 kw. Antenna heights, 100 and 10 feet. Data corrected to 30 feet.

the proper choice of routes. State highway maps of several counties drawn to a scale of 1 mile per inch were pasted together. On this composite map, eight radials spaced 45° apart and centered on the transmitter were drawn. For each radial, routes were selected which followed the radials as closely as practicable. Corrected radials were then drawn through the average of the routes followed.

Next, concentric circles were drawn, beginning with a half-mile radius and then continuing in one-mile intervals out to a distance of 50 miles. In other words, the second circle was drawn with a 1½-mile radius, the third circle with a 2½-mile radius, etc. The intersections of each circle with the proposed routes were carefully identified by travelling over these routes in the field car before any field-strength measurements were recorded. A typical sample of the notes made of these points is presented in Table I.

The map was cut into eight sectors for ease of handling in the field car. During the field-strength survey, the maps and the identifying notes were carefully followed in order that the recorder chart could be accurately marked by means of

TABLE I
TYPICAL DESCRIPTIONS OF MILE POINTS ON A RADIAL ROUTE

Miles	Northwest Radial Description
0.5	Opposite church on Hemphill Avenue, just beyond Fifth Street.
1.5	Before traffic light at Westinghouse plant.
2.5	At Echota Drive on right.
3.5	Opposite driveway and mailbox just beyond Sagamore Drive.
4.5	Where four-lane highway begins.
5.5	Opposite Georgia Power Company substation on left at curve.
6.5	At Beechwood Drive intersection (past East Beechwood).
7.5	At Fulton County edge of river bridge.
8.5	Engineering Experiment Station paint testing project on right.
9.5	At intersection of Shangri-La Drive on right.
10.5	At asphalt driveway and mailbox on right before top of hill.

the chronograph pen as each radial mile point was crossed.

CHART ANALYSIS

Since the recorder chart is advanced 7.5 inches per mile and the chart is divided in 0.75-inch intervals, these intervals conveniently represent one-tenth of a road mile. It is obvious that there are 10 or more of these one-tenth road mile intervals per airline mile traveled along the survey route.

The average recorder reading for each one-tenth road mile was determined from the recorder chart and was tabulated. Each recorder reading was converted to the corresponding field-strength meter reading by first referring to a calibration curve relating the linear divisions on the recorder chart to the semi-logarithmic readings of the field-strength meter, and then by multiplying this reading by the input attenuator constant.

The field-strength meter reading is converted to field intensity in microvolts per meter at 10 feet by use of the appropriate formula supplied by the manufacturer of the meter, taking into account the car antenna correction constant. Since received field intensities at a height of 30 feet are desired, the values obtained at 10 feet are multiplied by a factor of 2 for vertical polarization and by a factor of 3 for horizontal polarization.*

*Klingaman, G. W., "How to Make a Field Survey of an FM Station," *Broadcast News*, June, 1946, pp. 54-61.

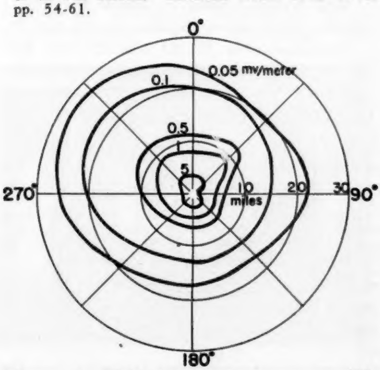


Figure 6. Field intensity contours, millivolts per meter. 1000 watts, 49.5 mc. Vertical polarization. Antenna heights, 100 and 10 feet. Data corrected to 30 feet.

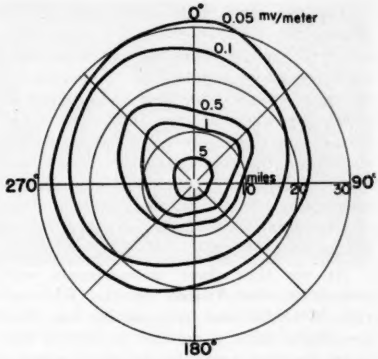


Figure 7. Field intensity contours, millivolts per meter. 750 watts, 99 mc. Vertical polarization. Antenna heights, 100 and 10 feet. Data corrected to 30 feet.

ANALYSIS OF RESULTS

The computed average field intensities for each radial were plotted as shown in Figure 5. From these curves, data were obtained to plot the field intensity contours shown in Figures 6, 7, and 8. All pertinent information is presented in the cutlines for these figures. It is important to note that the vertically-polarized surveys were made during the summer, while the horizontally-polarized survey was made during the winter.

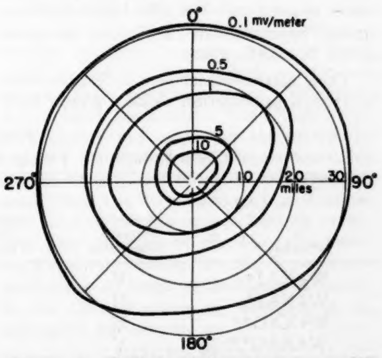


Figure 8. Field intensity contours, millivolts per meter. 600 watts, 99 mc. Horizontal polarization. Antenna heights, 100 and 10 feet. Data corrected to 30 feet.

The measured field intensities at 99 megacycles with horizontal polarization are much greater than the values obtained with vertical polarization at 99 megacycles, in spite of the fact that the equivalent radiated power was only 600 watts in the former case. The absence of foliage during the period that the horizontal survey was made might be expected to produce less attenuation of these waves. A careful check of the measuring equipment revealed no change in calibration.

At the time these measurements were completed, the Atlanta Journal FM station W4XAJ was transmitting on 99.8 megacycles with a radiated power of 600 watts from a vertically-polarized antenna 260 feet above ground. Comparison measurements were made of both W4XAG and W4XAJ at North Fulton Park, which is approximately 7 miles north of each station. The results of these measurements made with two different field intensity meters are presented in Table II.

It is evident from these measurements that W4XAJ was radiating a strong, horizontally-polarized component. However, neglecting the energy present in this component, W4XAJ should have produced a greater field intensity than W4XAG since the transmitting antenna heights are in a ratio of 2.6 to 1. Previous measurements made at the same location when both stations were transmitting vertically-polarized waves showed that W4XAJ had a field intensity approximately 2.5 times as great as the W4XAG signal.

These measurements seem to indicate that horizontal polarization yields a greater field intensity than vertical polarization at 99 megacycles in the Atlanta area. The fact that this section of Georgia is heavily wooded and that the field car antenna was almost continually shielded by trees may account for the increased attenuation of vertically polarized signals. A large proportion of the trees in this area are pines, which maintain heavy foliage during the winter months. It appears desirable that some additional measurements should be made during the summer in order to determine definitely the effect of the increased foliage on horizontally-polarized waves.

CONCLUSIONS

On the basis of this investigation, it appears that horizontally-polarized waves yield a greater field strength than vertically-polarized waves on 99 megacycles in the Atlanta area. This contradiction to the theoretical transmission characteristics of the waves may be accounted for by the greater attenuation of vertically-polarized waves caused by trees.

A comparison of vertically-polarized transmission on 49.5 megacycles with that on 99 megacycles indicates that the higher frequency will give as good a coverage as the lower frequency. High-power transmission in the new FM band of 88 to 108 megacycles should yield excellent coverage of the service areas.

The writer wishes to thank the Engineering Experiment Station, Professor H. L. McKinley, Mr. W. O. Garrett, and Mr. W. O. Drake for their assistance in pursuing the various phases of this propagation project.

TABLE II
COMPARISON OF FIELD INTENSITY MEASUREMENTS

Station	Receiving Antenna Polarization	Millivolts per Meter with: Measurements Corporation Type 58 Meter	RCA Type 301-B Meter, Linear Scale	RCA Type 301-B Meter, Log Scale
W4XAJ*	V	3.34	3.22	3.4
W4XAJ*	H	0.80	1.67	2.44
W4XAG**	H	3.52	3.54	4.08
W4XAG**	V	0.06	0.06	——

*Atlanta Journal Station W4XAJ on 99.8 megacycles. Equivalent power output, 600 watts. Transmitting antenna is a vertically-polarized "J" type fed with an open wire line at height of 260 feet.
**Georgia Tech Station W4XAG on 99 megacycles. Equivalent power output, 600 watts. Transmitting antenna is a horizontally-polarized square loop fed with a coaxial line and mounted at a height of 100 feet.

HYDRAULICS LABORATORY

Continued from Page 6

made whereby a second large pump might be added to this system to give an ultimate maximum capacity of 12 cubic feet per second, if required.

One of the most outstanding pieces of research equipment completed to date is a 3 x 3 x 35 foot steel and glass-walled flume, shown in Figure 3. Plans are now in preparation for a smaller flume with a gate-controlled head-bay section. These two pieces of equipment will be of great value for open-channel research in addition to demonstration and instruction. Two venturi tubes and a number of standard bend meters have been constructed and at present are being calibrated for use in the laboratory. A 20,000-pound-capacity weighing tank (Figure 4.), located on the upper main floor level, provides an accurate means of calibrating equipment which is located above the balcony level. Other pieces of equipment now in use include a nearly vertical line of transparent "Lucite" tubing which will be used to demonstrate phenomena of cavitation, losses due to sudden contraction and sudden expansion, piezometer design, pitot-tube practice, .etc. Also for demonstration and calibration purposes, a small pump circuit has been constructed of 1¼-inch Lucite tubing, a rotameter, and a series of transparent commercial valves. A large number of small pitot-static tubes

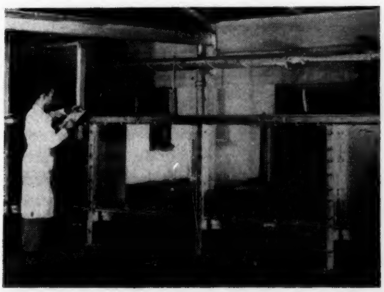


Figure 3. Partial view of the steel and glass 3 x 3 x 35 foot flume, adaptable to a wide variety of open-channel research studies.

Figure 4. Precise flow calibrations are made possible by this weighing tank arrangement on the upper main floor.

and static tubes have been built, and steps are being taken to provide taps for these instruments on nearly every length of pipe in the laboratory system. Delivery of a modern impulse-type water turbine has just been made, and it is expected that this piece of equipment will be in operation for instructional purposes within the next school term.

The laboratory is well supplied with modern instruments and accessories of all types. In addition to the pitot-static and static tubes previously mentioned, Georgia Tech shops have constructed other special devices not otherwise available. Through Government surplus, the laboratory has acquired a number of excellent manometers of various types, hand and machine tools, small pumps, and miscellaneous materials and supplies. A Price current meter, a Stevens miniature current meter, a rotameter, a Bentzel Tube, a wide selection of pressure gages and manometers, a Strobotac, several hook gages, and a 4 x 5 inch press-view camera and accessories are among the facilities purchased with departmental or Alumni Foundation funds. A well-equipped small shop has been developed as a necessary part of the laboratory, but the extensive shop facilities of the State Engineering Experiment Station are also conveniently available at all times. A darkroom is located in the Civil Engineering building as an adjunct to the laboratory.

FUTURE PLANS

The design and construction of facilities for the basic laboratory system are still going forward as rapidly as the avail-

able facilities and staff participation allow. As each piece of equipment is completed, necessary exploratory testing and calibrations must be made, revisions are often required, and refinements in instrumentation are frequently necessary.

It may be noted that for all facilities completed to date, water is intended as the fluid medium. There are several reasons for this. In the first place, for all but aerodynamic applications, water is our most important fluid. Furthermore, it is cheap, plentiful, and clean. Thus, it seemed appropriate to concentrate initial efforts on the development of the water-circulation system and its accessories. When properly interpreted, experimental data from the water-fluid laboratory can be applied to other fluids, including most liquids and, in some cases, even gases. Occasionally, however, fluid phenomena are encountered which are characteristic of the variability of density or viscosity of liquids, extremes of surface tension, or the compressibility of gases. Such phenomena demand the use of fluids other than water.

Plans for the basic laboratory include an air-metering system and a small oil-circulation system. The design and construction of these facilities are projects for the near future. A reaction-type turbine model including a transparent penstock, scroll case and draft tube, a dynamometer, and a complete modern Francis turbine, is a hope for the future.

RESEARCH

When all of the aforementioned equipment is installed, a considerable amount of the original floor space will still be available for the location of small research projects. An adequate amount of unreserved floor space is a primary need of any modern laboratory, especially one which is intended for open-channel hydraulic model studies. A good hydraulics research laboratory is not a compact one, in which a maximum number of fixed pieces of equipment are located, but rather one which is equipped to be readily adapted to any type of study which may be undertaken. The present building space is not adequate for such an ideal situation. It is reasonable to assume, however, that when the basic plan is completed, Georgia Tech will have one of the better small laboratories in the country.

Design and construction of the laboratory and its facilities, routine exploratory testing, devising laboratory experiments for undergraduate students in hydraulics, etc., have been and continue to be the major activities. Nevertheless, it is felt that carefully selected research will provide the necessary stimulus for recognition and future growth of the laboratory. Accordingly, a number of research projects are being planned, and the services of the hydraulics laboratory are being made available to industry. There will doubtless be more to report on this activity in the near future.

PATENTS

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written more naturally in language designed to support the claims adequately.

A common practice in claim drafting is to start with an introductory phrase which may form a setting for the invention or a starting point for the boundaries of the invention which the claim is to set forth. From that point on, the successful claim draftsman must be possessed of a good degree of imagination and full command of the English language. He must have the ability to look beyond the precise physical structure and to visualize how the same results might be achieved by modification or substitution, and he must draw the claims in terms sufficient to include as many equivalents as he can envisage without making them so broad as to include the prior art constructions or permitting them to be subject to attack for being broader than the invention. Specific claims as well as broad claims are desirable in any application, because it obviously would be considerably easier to win an infringement suit on such a claim than on a broader claim which might meet with unexpected defenses.

The invention may be restated in a reasonable number of different claims. The choice of language to include all allowable alternatives, and yet avoid the many forms of objection and rejection which may be raised, taxes the imagination and ingenuity of the most skillful patent attorneys.

THE FEE

A first fee of $30.00, plus $1.00 for each claim in excess of twenty, is required to be paid to the Government as a *sine qua non* part, upon the filing of each application for patent.

* * *

No patent grant is stronger than its claims, which in turn are not valid unless they properly depend upon the specification. The preparation of a proper patent application, then, is certainly as important from a legal standpoint as the invention itself; if the latter is not genuine, the grant is valueless; if the application has flaws, the patent may be indefensible. Whatever the case, the drafting of the patent application is an important step in the obtaining of legal protection for an invention.

INDUSTRIAL WASTES

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cies as the United States Public Health Service and the Georgia State Board of Public Health, and, through them, funds will be granted to such organizations as the Georgia School of Technology. In addition, cities may also receive monetary assistance for the planning of sewage treatment works.

In locating future plants which involve waste problems, industry must choose a location in which waste disposal is possible if utilization is not. While a company might like to employ the more readily available labor supply of a rural locality, stream conditions there may demand a high degree of waste treatment, so that it may have to join other industries in more congested urban areas where labor is more scarce but where water will be available as a less expensive disposal medium for liquid wastes. Eventually, research engineers and chemists will probably develop better methods for the mitigation of these difficulties, but these processes will evolve only if effort is concentrated upon them.

Georgia, in a sense, is fortunate that its past industrial growth has not been at such a rate that it has outstripped the growing knowledge of methods of waste treatment. Much research is still needed here and elsewhere, however, for problems are now more acute than ever before, and further industrial growth in certain fields—such as pulp and paper—may be seriously impaired if solutions are not forthcoming.

FELLOWSHIPS

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in research techniques and thinking. Moreover, few students, these days, can afford graduate study without financial as well as moral support.

The Georgia Tech Engineering Experiment Station is more than idly interested in graduate level research, for it feels, as do all divisions of the school, that the graduation of well-trained, research-minded engineers is a major contribution to the industrial development of this region. The Station itself administers and grants graduate research fellowships. Moreover, it provides graduate students with much specialized equipment which would otherwise be unavailable, and members of the research staff often teach graduate courses and serve as graduate advisors—men of a caliber unobtainable without an active research program.

Georgia Tech, in recent years, has received numerous fellowships for graduate research. Such fellowships are vital to the technical growth of an institution, for leaders in education and research are attracted to the faculty of a school which properly evaluates a strong graduate research program. Equally important, graduate students benefit from the availability of suitable funds for quality research and adequate living.

If science and engineering are to progress in a free economy, industry must continue to assume its share of the burden. This obligation does not end with the creation of private research subsidiaries, or with contracts for research projects. It requires that industry replenish the stock of fundamental knowledge which it has borrowed from the storehouse of the past and that industry must aid itself by helping students to prepare for their future scientific roles.

A-C NETWORK CALCULATOR LABORATORY

By GERALD A. ROSSELOT*

Georgia Tech's new A-C Network Calculator Laboratory has now been placed in service. This $120,000 instrument, the largest and most complete a-c network calculator in the United States, is housed in a newly completed portion of the Engineering Experiment Station's annex, itself built at a cost of $160,000.

Only 18 other a-c network calculators have so far been constructed in this country, because of their bulk and cost, although demand for their use has far outstripped their capacity. These network calculators are based on the simple principle that any electrical device—be it generator, transformer, motor, or transmission line—can be represented by a simple circuit consisting of an inductance or capacitance and a resistance, plus a power source. These equivalent circuits and power sources behave electrically just as do their full-scale counterparts.

No attempt will be made to present here more than a brief description of the utility and operations of the Georgia Tech instrument, since a more detailed account will appear in the next issue of THE RESEARCH ENGINEER, written by Herbert P. Peters, Supervisor in Charge of Studies and Operation of the Georgia Tech A-C Network Calculator. Since 1929, when the first a-c network calculator was completed, power companies and their engineers have made increasing use of this ingenious engineering tool to solve many electrical problems associated with the design and operation of electrical power systems. These solutions, made in a fraction of the time usually required for solving such problems mathematically, have resulted in economies that follow from maximum utilization of existing equipment, better service continuity, and assurance that capital expenditures, when necessary, will adequately fulfill system requirements.

In the design and arrangement of the new Georgia Tech a-c network calculator, every provision has been made to provide maximum production as measured in terms of calculator data per hour. Individual circuits are so arranged that controls for the units requiring adjustment during the course of a study are located close to the operator at the instrument desk.

The purchase of the Georgia Tech a-c network calculator was made possible by contributions to the Georgia Tech Alumni Foundation of $100,000 by the Georgia Power Company and $20,000 by other companies.

While the dedication of the Georgia Tech A-C Network Calculator Laboratory is another step forward in the School's program of technical and scientific service to industry, and the building in which the instrument is housed will also provide space for a low-temperature research laboratory, it is not inappropriate to reflect here upon the potentialities which are still undeveloped through lack of space for research.

As President Blake R. Van Leer has pointed out in his Annual Report for 1946-47, much of the Engineering Experiment Station's research work "is now scattered through temporary wooden structures, two old residences, and a temporary building built by the Federal Government. . . . With just a little more assistance from the State in the way of permanent facilities and permanent, trained personnel, the Station could readily be doing work worth well over $1,000,000 per year," a sum of minor significance in relation to the effects such work would engender. "No investment the State of Georgia can make will pay greater dividends than one in the Georgia Tech Engineering Experiment Station. But the State of Georgia must invest more if it expects more."

The Georgia Tech A-C Network Calculator Laboratory, therefore, must be considered primarily as a milestone in a path which has no end, a road marked to the rear by such achievements as the erection of the present Research Building, installation of an electron microscope, and erection of a food freezing laboratory. Science and engineering admit no boundaries and permit no lengthy celebration of accomplishments.

**Director, State Engineering Experiment Station, Georgia School of Technology.*